Innovations in Inland Ports and Shipping in the European Union: The Waterway Cross at Magdeburg, Germany

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Ladies and gentlemen, I enjoy having the opportunity to give a short talk on the waterway crossing in Magdeburg to you. Walt, thank you for putting me in such a good light with your introduction. It's not only my German type of accent, my school English is a bit rusty. So, I hope you will bear with me and find some interesting facts in my presentation.

First where do we find Magdeburg on the map. Magdeburg is a city of about 230,000 inhabitants in the former East Germany. It is a city with an old history, and it made history. On the slide we see Emperor Otto, II and his empire from the North Sea to the Mediterranean. In the 10th century he was the first ruler over a European entity and Magdeburg was his favorite capital.

We see the River Elbe in front of the Magdeburg Cathedral where Otto, II was buried. At that time rivers were the main, almost the only traffic carriers for people and goods. The waterways in Germany are formed by the large rivers Rhine, Ems, Weser, Elbe, and in the very east the river Oder. These rivers roughly flow from the south to the north. They were no longer single traffic lines, but became part of the waterway network when canals were built. 70 percent of all German cities with over 100,000 inhabitants are close to a waterway.

In this respect there have to mentioned the Main Danube Canal which links these two southern German rivers, and thus makes shipping possible from the North Sea to the Black Sea and the Mitteland Canal as the main east west link in Germany. The aim of the Mitteland Canal is to connect the areas of Berlin, Magdeburg, and Hanover with the major North Sea harbors as well as the industrial heart of West Germany, the Rhine Ruhr area. Starting in the west at the river Ems and moving forward to the east, the early parts of the Mitteland Canal were built between 1906 and 1938.

By finishing the ship lift in Magdeburg in 1938, the canal met the river Elbe. Originally the canal was designed with a surface width of 33 meters and a depth of three and a half meters and was to be used by rather small vessels only. Since 1965 the Mitteland Canal was being widened and deepened in order to make modern ships and push tows. Today up to 90 percent of the 320 kilometers of the Mitteland Canal are ready for the big inland navigation.

The biggest seaports for the German inland waterways are in Belgium and in the Netherlands. And the first place Rotterdam. Perhaps we will hear more about it from our next speaker, Mr. Henk Schroten. In long distance haulage about 1.4 billion tons were being transported in 1997. A comparison: if the whole volume of freights were loaded on trucks at the same time, they would stand on a 45-laned highway bumper to bumper around the equator.

Some 80 percent of the overall volume of traffic of German waterways takes place on the River Rhine alone. An increase of the transport volume by 23 percent was recorded between 1991 and 1999. Considering the individual traffic carriers, this means for the roads a disproportionate increase, for the waterways at least an increase of about 12 percent and for the railways a real minus.

There will be a tremendous growth of commercial traffic in the perspective until 2010. Most of the cargo will be moved on roads. Railway and inland navigation will still make up only a small part.

We can see the development of the individual traffic carriers of Germany on this simple slide. The same abscissa and nearly the same ordinate. The ordinate not in absolute numbers, but in percent. You see the importance and the priority of the trucks. Our job is to make a change in this development possible.

At the time of the reunification of Germany, traffic and transportation projects were developed. The intention was to closely connect the traffic infrastructure of both German countries. This new infrastructure was to be a basis for the economic development in the former East Germany. The political intention was to support environmentally friendly traffic carriers, that is the railways and the waterways.

For the 17 traffic and transportation projects, a volume of investment of about $38 billion dollars has been calculated. This investment will be funded completely by the German government over a period of about 20 years.

Among the 17 projects, there is only one representing the system waterway-ship-port: the project number 17, the link between Hanover, Magdeburg, and Berlin. For this, an investment of about $2.3 billion dollars is necessary.

Let us have a look with a magnifying glass. In the very west we guess the city of Hanover. In the middle we see the waterway crossing between the River Elbe and the Mitteland Canal. And in the east we find the capital of Berlin, the end of the project. In the very east, we notice the River Oder with the border to Poland. Perhaps there will be another challenge with the expansion of the European Union.

Keyword European Union. We've heard a lot of the TEN. I'll make it very short. The TEN as well as the transportation project number 17 can be supported by the European Union on request. There is a limit of support at ten percent of the total investment. Only projects with guaranteed main financing will be supported. European Union acts and guidelines must be kept, especially the Fauna Flora Habitat Guidelines and the Antitrust Act.

Construction operation and maintenance of the about 7,300 kilometers of waterways in Germany are the responsibilities of the Federal Waterways and Navigation Authority, which is a part of the Federal Ministry of Transportation Building and Housing. The funding of the waterways is financed completely by the government.

In 2001 the cost for the operation, maintenance, and investment amounted to $0.9 billion dollars. The about 15,000 members of human resources caused costs of about $0.6 billion dollars.

As mentioned before, there were plans to build a construction to lead to the Mitteland Canal as a bridge right over the river Elbe in the area of Magdeburg as early as in the 1930's.

They had then already started to build a 1,000 meter long aqueduct.In the section of the Foreland Bridge three-link-bows consisting of concrete were set up. The bridge over the river itself should have been a steel construction. However, due to World War II, the construction had been left unfinished in 1942.

On the left we see the construction site of the Foreland Bridge planned and built in concrete. This a photo from the year 1939. On the right we see the situation in 1995. From above we see the Mitteland Canal coming, still waiting to cross the river Elbe.

Today in order to get from the Mitteland Canal into the Elbe-Havel Canal and further on to Berlin and to Poland, ships have to take a detour. First they need to pass the ship lift Rothensee to reach the river Elbe. After that, they travel downstream to take the lock Niegripp for descend into the Elbe-Havel Canal. This route is 12 kilometers longer than the direct crossing.

Moreover big vessels cannot use the ship lift Rothensee, which is only 82 meters long. Yet, the main problem for the cargo vessels is the often low water level of the River Elbe. It can happen that for several weeks ships coming from Hanover have to lighten in Magdeburg. And quite often, the entire shipping is closed down.

Under these conditions, inland navigation to and from Berlin is highly uneconomical. This traffic route is not reliable for the ship owners, which is a considerable disadvantage in competition.

After checking alternatives, the former Ministry of Traffic decided on the solution of an aqueduct in connection with a double lock east of the River Elbe to descend to the Elbe-Havel Canal. The slightly cheaper solution including a dam and a lock in the River Elbe, to make the shipping independent from the low water level throughout the year, had been rejected.

The reason was the far larger infringement on the environment. Such a solution would have created difficulties in the social acceptance. In the profitability analysis, one year of delay would have cost about $100 million dollars.

The Magdeburg ports will be linked to the east west waterway connection through the new lock Rothensee as a bypass to the older ship lift to make the passage for modern large vessels possible. Since May, 2001 Magdeburg ports can be reached by modern ships as long as 185 meters, as wide as 11.4 meters, and with a draaught up to 2.8 meters. Those ships may transport up to 3,600 tons.

In the east west waterway, a single lock to descend to the Elbe-Havel Canal is insufficient. At this point a double lock is being constructed. The Aqueduct, the double lock, and the connecting canals are still under construction. Traffic will be opened on this central part of the traffic and transportation project on October the 3rd in 2003 at the latest, the anniversary of the German reunification.

This talk is part of panel 4, advanced technologies. I will show you our very first and enthusiastic plans. You see our fantastic highway crossing for ships. It was the outcome of some good ideas under the influence of the Christmas party in 1998.

After giving an overview, I will show you some special features on the construction of the waterway crossing. First the aqueduct over the River Elbe. The aqueduct is predominately loaded with rested the weight of water. The decisive weight is determined by constant weight of water and construction material.

Furthermore, there are wind and traffic, possibly a ship sinking to the bottom, a bump by a ship, pressure by ice, and an earthquake. You wouldn't believe it, but we had an earthquake in the 17th century. You can read in the Chronicle of Magdeburg that because of that, chickens fell off their roosts.

The demands of differences of the temperature within the construction caused the biggest difficulties. When the trough is empty, the construction must tolerate differences in temperature of more than 50 degrees celsius.

The Foreland Bridge as well the River Bridge are going to get a trough made of steel each in one piece. The thickness of the metal sheet is up to 80 millimeters. The troughs weigh about 24,000 tons in total. That is about 10,000 tons for the River Bridge and 14,000 tons for the Foreland Bridge. Only the welding material amounts up to 435 tons. Both troughs are being delivered to the construction site in about 250 segments. The heaviest part weighs about 150 tons. At least the parts for the Foreland Bridge have been transported by ship and not by truck.

The River Bridge is about 228 meters long. For the shipping on the River Elbe, the span is about 106 meters wide. It is 6.5 meters about the highest water level. That passage is possible for ships with three containers on top of each other. The main outside girders of the troughs are about eight meters high and four and a half meters wide. With a water level of 4.25 meters in the troughs there remains a height of only 1.9 meters for the construction of the cross girders.

On the outside of the main girder, there is a steel framework. The inside of the main girder consists of a closed steel wall. This is the skin plate with water behind. This construction creates a lot of difficulties in structural calculation. The stiffness, for example, is different inside and outside. Thus, the bearings must be put out of the center of the girders.

This is the reality. We see the steel framework, the piers, and a couple of little towers. Some have said that we could have got a straight bridge for the money. But think of the water weight of about 150 tons per meter. We definitely need an .5 meters higher bridge in the middle of the piers when the trough is empty. This camber is necessary to avoid a deflection in case of a water filled bridge.

It's a talk of its own to describe the 24 hour moving or launching of the 10,000 tons River Bridge across the River Elbe in time of a high flood on the river. So, it's only an impression. The Foreland Bridge is about 690 meters long. This is necessary to ensure the cross section for the River Elbe in case of flood.

Another idea worth remarking: the bridge is made of steel of about 1,000 meters long. It is about 1.5 meters longer in summer than in winter. The linking construction is made in profiled rubber material in form of an omega, larger in summer and smaller in winter.

On this slide we see the piers of the Foreland Bridge made of concrete. When you look upon the shape, what does it look like? Our aqueduct shown in a watercolor painting is not only an extraordinary technical construction, but also makes its impression on the country's scenery. This is why the architectural design is very important. Right from the beginning the architect and the engineer have been working closely together.

There are three special design features. The two ends of the aqueduct are marked by a couple of little towers each in front of a prism, as is the division of the River Bridge and the Foreland Bridge. The steel framework of the girders avoids the impression of a rebuffing eight meters high, closed technical construction. At the same time it is a bow to the design of our ancestors. The piers of the Foreland Bridge resemble a ship rib. So from a distance, the purpose of this construction can be recognized.

As the construction and owning party, we did not alone decide on the color design of the construction. We called in the decision of the adjacent municipalities, the rural districts, and the capital Magdeburg. As the region sees this junction as a blue cross, the decision was for a blue aqueduct to match. You see our logo.

Because of the possible large distortion of the super structure, spherical bearings are necessary for the River Bridge. With a weight of 13,500 tons per bearing, we have to manage an obstacle. It is the largest bearing in Germany, and there is no standardized bearing for this weight.

In this case we need a permit for this isolated case. The authority who gives this permit is the Federal Ministry of Transportation, Building and Housing. A group of experts defined the demands and the standards for this bearing. The expert group was composed of the producer of the bearing, two University Institutes, the Federal Waterways Engineering and Research Institute, and our Senior Engineer, Professor Hering from the University of Braunschweig. You see him with his camera on the slide. He is responsible for observing the building regulations.

One problem, for example, was that the sliding plates of teflon, the material of the slip surfaces could not be delivered in one piece. The material had to be put together. You see it on this slide. The question was whether this compound can be kept in good condition over the prospective period of use of about 80 years. The experts decided to carry out an experiment. A model of a part from the bearing on a scale of 1 to 1 had to be built.

At the University Institute at Stuttgart, this model was loaded with a weight of 35 Newton per square millimeters and was moved for a distance of about two kilometers. This stretch is more than a bearing should move in its prospected period of use. The experiment ended successfully, and we received the permit.

Because of two experts, we needed the help of the University Institutes. First the experience and second the equipment for such an experiment. We decided to use this type of spherical bearing for the Foreland Bridge, too. Experiences with hot bearings at other aqueducts in Germany have not been truly and really convincing.

We had to change some bearings there after only 25 years in use. We do not know yet exactly what this damage was caused by. All the evidence seems to indicate that this is not only a problem of the type of the bearing, but also a problem of the superstructure just above the bearing. It looks very much that's if it is too soft at this point. Thus, we got peaks of pressure on local parts of the bearing which destroyed them.

But there is another obstacle. In the case of a waterless trough and sunshine at the same time, the super structure takes off from the bearings which would damage them. So, this case must not happen.

We decided to build a construction to put down the super structure to prevent any negative pressure. The whole system is very sensitive, and a damage would be very expensive because it's highly complicated to change a bearing. That is why a measuring of the pressure in each of the over 100 bearings is absolutely necessary. There did not exist a method of measuring the pressure in the curved surface of the spherical bearing. The producer developed this measuring technique.

And by now a patent has been granted for this. A welcome side-effect of the measuring is the early recognition of possible impending damages.

Another subject, the double lock Hohenwarthe. What do you think about it? It looks like a super playground for grown up engineers, doesn't it? We heard a lot of environmental impacts. On this slide we can see one. About 50 acres it was only sand. The spending for the compensation at the waterway cross amounts to about three percent of the technical investment.

This is cheap in comparison of segments of widening a canal in the middle of a city. There we reached up to 30 percent of the technical investment.

The double lock Hohenwarthe at the eastern bank of the River Elbe enables ships to overcome the differential altitude of 18 meters between the Mitteland Canal and the Elbe-Havel Canal. The usable lengths of the new locks are 190 meters each with a width of twelve and a half meters. To reduce the loss of water, all ship locks in Magdeburg are designed as water saving locks. At each side of the lock, you can see three water saving basins of different levels.

With the help of these basins, we can save up to 60 percent of the water necessary for the entire operation cycle of locking. We want to build this lock a few hundred meters to the west. There is a homogenous underground and reliable construction would have been built. But at that site, the shelf of earth ends and, therefore, there is the danger of an earthquake. You remember the chickens? Thus, the development site had to be moved to the east, but there is a very inhomogeneous underground there.

Such an underground reacts very sensitively to the pressure from a lock, because there are not only rested weights, but also dynamic weights by operating the lock with changing water levels. Especially a layer of clay can get quite nasty. Its distortions are not elastic. A possible crack between the stiff concrete construction and the soil however is dangerous as the passage for water. Therefore, a robust construction is needed.

We decided to build a monolithic concrete bottom about 255 meters long, about 55 meters wide, and 5.5 meters high. We did not build a monolithic object without any joint up till now. But this new type of construction seems not to be safe enough. So we put the concrete bottom on 1,200 concrete piles each more than 12 meters long, in total about 17 kilometers. We received the shallow and deep foundation made up of a foundation slab and drilled piles.

Ladies and gentlemen, we need the social acceptance for the planning, for the permission to build, and for the building itself. So we include the public wherever and whenever possible. For example, you see the results of a painting competition in the schools of Magdeburg. This is the first prize picture. It is advanced technology from a child's point of view; only a friendly policeman with a swimming belt in the middle of the waterway cross.

For more information, have a look on our home page www.wna-Magdeburg.DE. Jerry, thank you for your help. Thank you very much for your attention.